Name:_____

Using Blood Types to Identify Babies and Criminals… and Maybe Baby Criminals???

How Blood Typing Works

I'm sure many of you have seen TV crime shows or even reality shows where blood tests are used to determine "who done it" and if "you are the father!" How does this work? How do you acquire your blood type? It is all about genetics. The most common classification system to type blood is the ABO System (pronounced A-B-O). Any individual can be type A, type B, type AB, or type O. Your type is determined by certain carbohydrates that are either present or not present on the surface of your red blood cells.

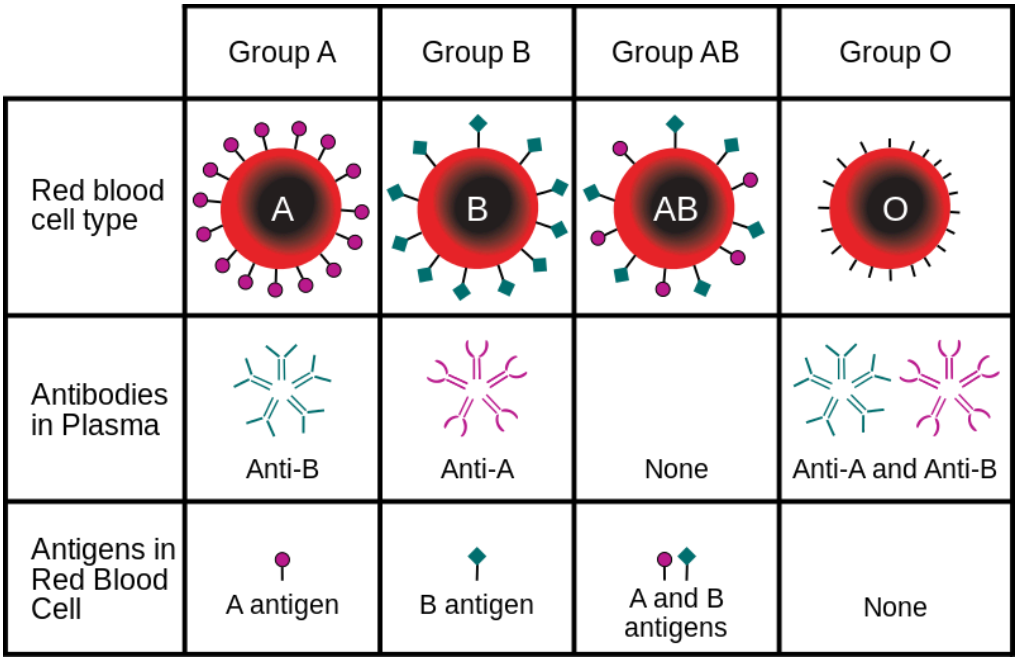


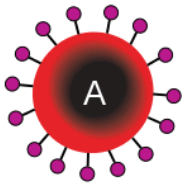
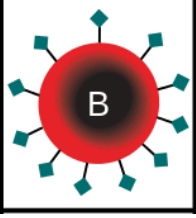
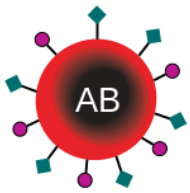
Image Source: https://commons.wikimedia.org/wiki/File:ABO_blood_type.svg

Type A blood has "A Carbohydrates" on their surface, type B blood has "B Carbohydrates" on their surface, and type AB blood has both "A Carbohydrates" and "B Carbohydrates" on their surface. Type O blood has no distinguishing carbohydrates on their surface and is called type O as in zero carbohydrates. These carbohydrates are sometimes referred to as **antigens** as they signal to white blood cells that these cells are good and allowed to be in your body.

Antibodies

In order to protect ourselves from blood infections, scientists believe that humans have developed **antibodies,** or Y-shaped proteins which function to identify and help remove foreign antigens or targets such as viruses and bacteria, against other blood types. This means that type A blood has antibodies against type B blood. Type B blood has antibodies against type A blood. Since type AB blood has both carbohydrates it has no antibodies, and type O blood has both A and B antibodies.

REVIEW QUESTIONS:

	Group A	Group B	Group AB	Group O
Red blood cell type				

1. What blood type(s) will have A-antibodies?_____
2. What blood type(s) will have B-antibodies?_____
3. What blood type(s) will have both A and B-antibodies?_____
4. What blood type(s) will have no antibodies?_____

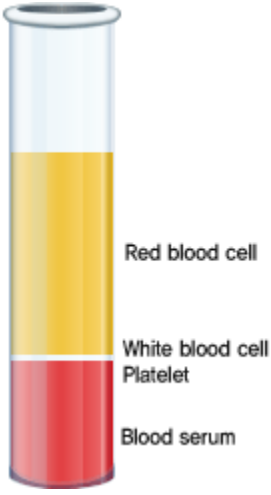
Blood Transfusions…Who Can You Give Blood To?

If you are given a blood transfusion that does not match your blood type, the antigens in your blood will attack the donor blood and cause massive blood clots to form, ultimately killing you. So, who can get your blood and who can you give it to?

Type A blood can give blood to other type A blood types as well as type AB. The same applies to the type B blood type. Type O individuals are considered the "universal donor" because there are no carbohydrates on their blood to be attacked by antibodies. Type AB individuals are the "universal receiver" as they have no antibodies in their blood to attack type A, B, or O.

5) UNDERSTANDING QUESTION: Fill in the chart below…

Blood Type	*Donate to…*	*Receive from…*
Type A		
Type B		
Type AB		
Type O		



HEY! Doesn't type O have A and B antibodies?!? How can they be the universal donor?

Good question! (Even though you did not ask it…) Whole blood, red blood cells and plasma together, is often not used in blood transfusions. The antibodies in your blood are in the plasma. When we prepare blood to be donated the red blood cells (Type A, B, AB, or O) are separated from the plasma and suspended in another fluid and injected into the patient.

Genetics of Blood Types

The ABO blood types result from three alleles that interact in a codominant fashion. There are two alleles that result in A or B carbohydrates and one that results in no carbohydrates at all.

Allele	Codes for…
I^A	This version puts type A carbohydrates on the surface of your red blood cells.
I^B	This version puts type B carbohydrates on the surface of your red blood cells.
i	This version puts no carbohydrates on the surface of your red blood cells.

Each person has two copies of the gene. One from their biological mother and one from their biological father. These blood types are codominant, however, the *i* allele gets masked when paired with either an I^A or I^B.

6) UNDERSTANDING QUESTION: Fill in the chart below…

Genotype	Phenotype (blood type)
$I^A I^A$	
I^A i	
$I^A I^B$	
$I^B I^B$	
I^B i	
i i	

7) Which blood type exhibits codominance? _____

8) In the I^Ai blood type, which allele exhibits dominance? Explain your reasoning.

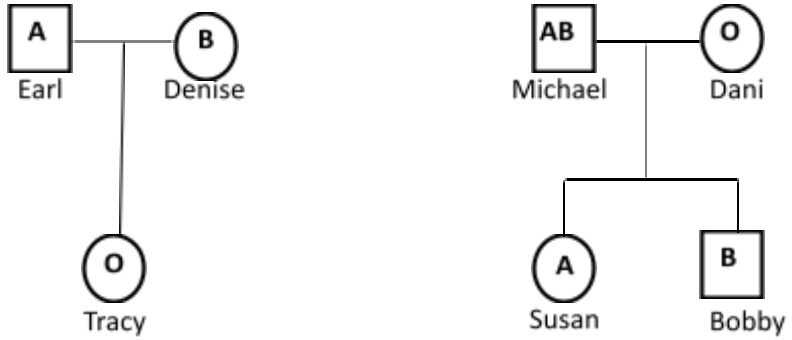
9) Cross a person with I^Ai type A blood with a person with I^B I^B type B blood.

10) What blood types could their children be?

NOW…WHOSE BABY IS IT?

Now you are ready to determine if Earl and Denise's baby girl was switched at the hospital with Michael and Dani's baby girl.

Earl and Denise were given their baby girl, that they named Tracy at the hospital. Her skin tone is darker than they were expecting and want to do a blood test to see if she was switched with Michael and Dani's baby girl named Susan. Below is a pedigree of the known blood types. Your job is to determine if the children's blood types are possible given the parent's blood types.



11) What possible genotypes could Denise be and still have type B blood?

_____

12) What possible genotypes could Earl be and still have type A blood? _____

13) Draw a Punnett Square for Earl and Denise. Write the possible phenotypes and genotypes for their children.

Genotypes Phenotypes

14) What possible genotypes could Dani be and still have type O blood? _____

15) What possible genotypes could Michael be and still have type AB blood? _____

16) Draw a Punnett Square for Michael and Dani. Write the possible phenotypes and genotypes for their children.

Genotypes Phenotypes

17) Did the hospital make a mistake? Explain your reasoning using your Punnett Squares.

Rh Factor, How We Get the + or –

There is an additional factor called the Rhesus Factor, that is named so because it was first discovered on Rhesus Monkeys. We simply call it the Rh Factor. The Rh factor is a type of protein on the surface of red blood cells. Most people who have the Rh factor are Rh-positive. Those who do not have the Rh factor are Rh-negative. This is useful to use if we have people with the same blood type. This can add additional blood types. Now we can be A+, B+, AB+, O+ or A-, B-, AB-, O-.

NOW…WHO KILLED ERNIE?

Background

Ernie Bell- Victim, was a 23 year old college senior who was majoring in Cell Biology. He was paying for school by working at a local fitness center as a personal trainer. He had just been promoted to head personal trainer before he was killed.

Crime Scene

Ernie's body was found in the men's locker room at the fitness center he was a trainer at. He was found at 12:30am by the night janitor, **Harvey Williams.** The victim was strangled and was wearing a bath robe. There were signs of a struggle in the shower room, including a broken mirror with blood smeared across the surface.

Suspects

Harvey Williams, Janitor – Harvey found Ernie's body at 12:30am while he was cleaning the men's locker room at the fitness center. He noted that the gym usually was closed at 10pm to the public, but employees were often allowed to stay after hours to work out and do their paperwork. He said Ernie almost always stayed late at night and was often joined by his girlfriend or other employees. Harvey did not arrive at the gym until 12am that night and did not see any other people in the building at that time.

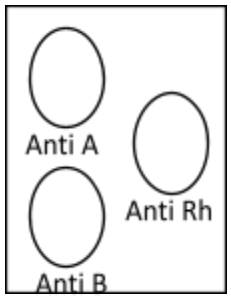
Mike Brown, Co-worker – Mike is a 34 year old personal trainer at the same fitness center. He had been working at the gym for about 6 years when Ernie was hired. He often made it known that he was unhappy that Ernie was promoted to head trainer after only working at the gym for a little under one year. Mike thinks he was promoted because Ernie spends so much time with Sara Spangler, the gym owner. However, Mike was recently fired from his job and had a restraining order placed on him by Sara, the gym owner.

Sara Spangler, Gym Owner – Sara is the 42 year old owner of the local fitness center that Ernie was employed at for about a year. She has owned the gym for 10 years. She was widowed some time ago and spends a lot of time outside of work with Ernie. When her employees tease her about this she simply states that he has become a good friend and someone to talk to. Sara recently put a restraining order on one of her former employees, Mike. This was because he tried every change he got to ask her on dates and she always refused. When Ernie was hired he became jealous of Sara and Ernie's relationship and began stalking Sara outside of work.

Barbra Nicholson, Ernie's Girlfriend – Barbra is Ernie's girlfriend of two years and is also a senior at the college Ernie attends and is studying Creative Writing and Literature. She has suspected for some time that Ernie has been cheating on her with his boss, Sara. Once he was promoted after working only a short time she

knew something was fishy. She tried to be with Ernie at the gym as much as possible in order to "keep and eye" on him and Sara.

Your mission- use blood typing technology to try and figure out who killed Ernie. There are several different blood samples to test as outlined below.

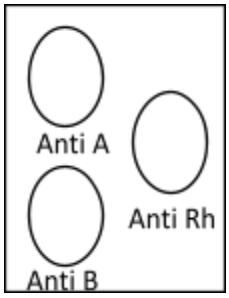


To the left is a blood test well plate. Put samples of the blood in each indent, only one drop is necessary. In the top left well, place a drop of Anti-A serum and in the bottom left place a drop of Anti-B serum. The well to the right should receive a drop of Anti-Rh serum. With SEPARATE TOOTHPICKS to avoid contamination, gently stir the blood and serum mixture. If the blood clots or looks grainy, that means that those carbohydrates are in fact present in the blood.

***For example**, If the A well clots and the B well clots and the Rh well doesn't clot, the sample is type AB- blood. If the A well doesn't clot and the B well doesn't clot and the Rh well clots, the sample is type O+ blood.*

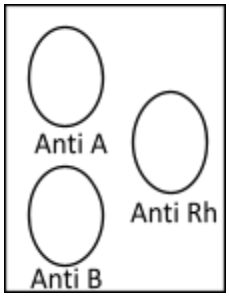
In the well plates below, mark each well with a + if the blood clotted and leave it blank if the blood did not clot.

Ernie Bell



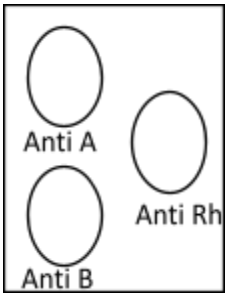
Blood Type_____

Harvey Williams



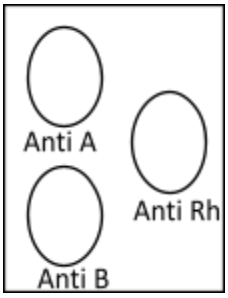
Blood Type_____

Mike Brown



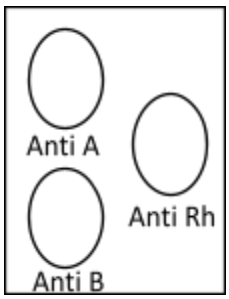
Blood Type_____

Sara Spangler



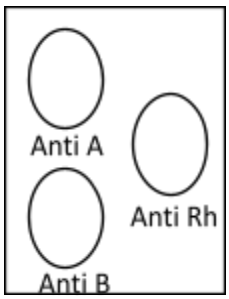
Blood Type_____

Barbra Nicholson



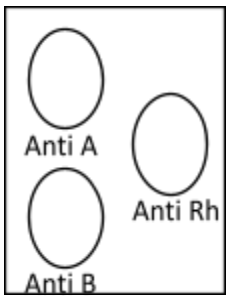
Blood Type_____

Stain on Ernie's Bath Robe



Blood Type_____

Blood From Broken Mirror



Blood Type_____

18) Based on your blood type analysis, who do you think killed Ernie? Why?